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FORM PTO-1300 (REV. 9-2001)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER 089478-000000US	
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371				U.S. APPLICATION NO. (DO/EO/US) PCT 19 <b>10/088951</b>	
INTERNATIONAL APPLICATION NO. PCT/AT 00/00255		INTERNATIONAL FILING DATE September 22, 2000		PRIORITY DATE CLAIMED September 22, 1999	
TITLE OF INVENTION METHOD AND APPARATUS FOR RECYCLING PET-MATERIALS					
APPLICANT(S) FOR DO/EO/US Helmut BACHER, Helmuth SCHULZ, Georg Wendelin					
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:					
<p>1. <input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</p> <p>2. <input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 36 U.S.C. 371.</p> <p>3. <input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.</p> <p>4. <input checked="" type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (Article 31).</p> <p>5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 37(c)(2))</p> <p>a. <input checked="" type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau).</p> <p>b. <input type="checkbox"/> has been communicated by the International Bureau</p> <p>c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).</p> <p>6. <input checked="" type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).</p> <p>a. <input checked="" type="checkbox"/> is attached hereto.</p> <p>b. <input type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4).</p> <p>7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).</p> <p>a. <input checked="" type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau).</p> <p>b. <input type="checkbox"/> have been communicated by the International Bureau.</p> <p>c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</p> <p>d. <input type="checkbox"/> have not been made and will not be made.</p> <p>8. <input checked="" type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</p> <p>9. <input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</p> <p>10. <input type="checkbox"/> An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</p> <p><b>Items 11 to 20 below concern document(s) or information included:</b></p> <p>11. <input type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.</p> <p>12. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.</p> <p>13. <input checked="" type="checkbox"/> A FIRST preliminary amendment.</p> <p>14. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment.</p> <p>15. <input type="checkbox"/> A substitute specification.</p> <p>16. <input type="checkbox"/> A change of power of attorney and/or address letter.</p> <p>17. <input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.</p> <p>18. <input type="checkbox"/> A second copy of the published international application under 36 U.S.C.</p> <p>19. <input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).</p> <p>20. <input checked="" type="checkbox"/> Other items or information:</p> <p>International Search Report, ADS</p> <p>Small Entity Statement</p>					

US Application No. (if known) <b>107-088951</b> INTERNATIONAL APPLICATION NO PCT/AT 00/00255		ATTORNEY'S DOCKET NUMBER 089478-000000US	
21. <input type="checkbox"/> The following fees are submitted:		<b>CALCULATIONS PTO USE ONLY</b>	
<b>BASIC NATIONAL FEE (37 CFR 1.492(A) (1) - (5)):</b> Neither international preliminary examination fee (37 CFR 1.492) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO ..... \$1040.00  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search report prepared by the EPO of JPO ..... \$890.00  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... \$740.00  International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... \$710.00  International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)(4) ..... \$100.00		\$890.00	
<b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b> Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).		\$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total claims	30 - 20 =	10	x \$18.00
Independent claims	1 - 3 =		x \$84.00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ + 280.00
<b>TOTAL OF ABOVE CALCULATIONS =</b>			\$1070.00
<input checked="" type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.			+ \$535.00
<b>SUBTOTAL =</b>			\$535.00
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).			\$
<b>TOTAL NATIONAL FEE =</b>			
Fee for recording the enclosed assignment (37 CFR 1.2(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property			+
<b>TOTAL FEES ENCLOSED =</b>			\$535.00
		Amount to be refunded:	\$
		charged:	\$
a. <input type="checkbox"/> A check in the amount of \$_____ to cover the above fees is enclosed. b. <input checked="" type="checkbox"/> Please charge my Deposit Account No. <u>20-1430</u> in the amount of \$ <u>535.00</u> to cover the above fees. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>20-1430</u> . A duplicate copy of this sheet is enclosed. d. <input type="checkbox"/> Fees are to be charged to a credit card. <b>WARNING:</b> Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038			
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.			
SEND ALL CORRESPONDENCE TO:		SIGNATURE <u>J. George Seka</u>	
J. George Seka Townsend and Townsend and Crew, LLP Two Embarcadero Center, Suite 800 San Francisco, CA 94111-3834		DATE <u>03/22/02</u> J. George Seka NAME <u>24,491</u> REGISTRATION NUMBER	

Attorney Docket No. 089478-000000US  
Client Reference No. 11243/4/zie

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re U.S. National Phase of:  
PCT/AT 00/00255

HELMUT BACHER, et al.

Application No.: Not yet assigned

Filed: Herewith

For: METHOD AND APPRATUS FOR  
RECYCLING PET-MATERIALS

PRELIMINARY AMENDMENT

San Francisco, CA 94111  
March 22, 2002

Assistant Commissioner for Patents  
Washington, D.C. 20231

Sir:

Prior to the examination of the above-referenced application, please enter the following amendments and remarks.

IN THE CLAIMS:

Please substitute the following amended, clean versions of the indicated claims (a marked-up version of the changes to the claims is attached to this Amendment):

3. (amended) Process according to claim 1, characterized in that also the temperature of the main processing step is kept below the plasticizing temperature of the PET-material.

4. (amended) Process according to claim 1, characterized in that for PET-pieces and/or milled PET-bottles the pre-processing step, that preferably is performed under environmental pressure, is performed at a temperature range of 140 to 190°C, preferably 150 to 160°C, and at simultaneous mechanic treatment or, respectively, applying power that causes heating, by means of at least one mixing and/or comminuting element, wherein the

average dwell-time of the PET-material or, respectively, the duration of pre-processing, amounts to 35 to 65 min, preferably 40 to 60 min.

5. (amended) Process according to claim 1, characterized in that for PET -foils and/or PET-fibers and/or PET-flakes, the pre-processing step, that preferably is performed under environmental pressure, is performed at a temperature range of 170 to 200°C, preferably 180 to 200°C, and at simultaneous mechanic treatment or, respectively, power applying that causes heating, by at least one mixing and/or comminuting element, wherein the average dwell-time of the PET-material or, respectively, the duration of pre-processing, amounts to 10 to 30 min, preferably 10 to 15 min.

6. (amended) Process according to claim 1, characterized in that the PET-material is subjected to the pre-processing step in a continuous flow.

7. (amended) Process according to claim 1, characterized in that the pre-processed PET-material is subjected to an intermediate storage between the pre-processing step and the main-processing step, the duration of this storage corresponds to 80 to 120 % of the duration of pre-processing step, and that the pre-processed PET-material is kept during the intermediate storage and/or during conveying to main-processing at a temperature that is as constant as possible, in particular 130 to 190°C, preferably 150 to 170°C.

8. (amended) Process according to claim 1, characterized in that during the main-processing step that is performed under vacuum, in particular under a pressure of less than 20 mbar, preferably less than 10 mbar, the pre-processed PET-pieces and/or the milled bottle material is mechanically treated at a temperature of 170 to 210°C, preferably 180 to 200°C, or is subjected to a power introduction that causes heating by at least one, preferably rotating, mixing and/or comminuting element, wherein the average dwell-time of the PET-material or the duration of the main-processing step, respectively, amounts to 40 to 100 min, preferably 50 to 90 min.

10. (amended) Process according to claim 1, characterized in that at the main-processing step that is performed under vacuum, the pre-processed PET-foils and/or PET-fibers are processed at a temperature of 160 to 210°C, preferably 170 to 205°C, or, respectively, are subjected to a mechanic power introduction that causes heating by at least one

mixing and/or comminuting element, wherein the average dwell-time of the PET-material or the duration of the main-processing step, respectively, amounts to 5 to 25 min, in particular to 10 to 15 min.

12. (amended) Process according to claim 5, characterized in that at least one rotating mixing and/or comminuting element is used.

13. (amended) Process according to claim 1, characterized in that the PET-material is comminuted before pre-processing to sizes of 15 to 25 mm.

14. (amended) Process according to claim 1, characterized in that the PET-material to be processed is pre-comminuted and/or washed and/or pre-dried before the pre-processing step.

15. (amended) Process according to claim 1, characterized in that the PET-material is supplied from a main-processing apparatus (4) to the extruder (8) under vacuum conditions or, respectively, that the vacuum existing within the main-processing apparatus (4) acts into the inlet section of the extruder (8).

16. (amended) Apparatus for recycling of PET-material, in which the PET-material to be processed is dried, crystallized and plasticized or, respectively, molten, and the melt, if desired after filtering, is processed to PET-granulate, for performing the process according to claim 1, characterized by two processing steps, in the first of which there is provided for pre-processing of the supplied PET-material a pre-processing device (3) having mechanical processing elements (5) for drying and simultaneously crystallizing the PET-material at elevated temperature and that this first step is followed by a second processing step comprising an evacuable main-processing device (4) having mechanical processing elements (5') for further drying, crystallizing and temperature increase of the PET-material supplied by the pre-processing device (3).

18. (amended) Apparatus according to claim 16, characterized in that as well within the pre-processing device (3) as within the main-processing device (4) there is provided at least one rotating mixing and/or comminuting element (5, 5') which mechanically treats and heats the PET-material.

21. (amended) Apparatus according to claim 16, characterized in that an intermediate storage means (6) is inserted between the pre-processing device (3) and the main-processing device (4), the volume of this storage means (6) corresponds to 100 to 200 % of the volume of the pre-processing device (3).

22. (amended) Apparatus according to claim 6, characterized in that between the pre-processing device (3) and the intermediate storage means (6) and between the intermediate storage means (6) and the main-processing device (4) a thermically isolated and/or heated conveyor unit (7) each is provided, preferably a conveyor screw or an extruder.

23. (amended) Apparatus according to claim 16, characterized in that the volume of the main-processing device (4) amounts to 80 to 200% of the volume of the pre-processing device (3), in particular to 100 to 180 %.

24. (amended) Apparatus according to claim 16, characterized in that an extruder (8) is connected to the main-processing device (4), in which extruder the PET-material taken from the main-processing device (4) is heated to a temperature of 260 to 275°C and is plasticized or molten, respectively.

26. (amended) Apparatus according to claim 24, characterized in that the extruder (8) comprises at least one de-gassing zone (9) to which a vacuum pump (10) is connected by which within the de-gassing zone (9) a pressure of less than 40 mbar, in particular less than 10 mbar, can be adjusted.

27. (amended) Apparatus according to claim 16, characterized in that a filtration device (11) for PET-melt is connected to the extruder (8) and that, if desired, a device (12) for producing finished products or semi-finished products, for example PET-granulate, is connected to this filtration device (11).

29. (amended) Apparatus according to claim 16, characterized in that the pressure in the main-processing device (4) is adjustable to less than 150 mbar, preferably less than 20 mbar.

30. (amended) Apparatus according to claim 16, characterized in that an additional heating for the pre-processing device (3) and/or for the main processing device (4) is provided.

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REMARKS:

Claims 1-30 are pending.

Amendment is made to eliminate all multiple dependencies from the claims,  
thereby avoiding the need to pay the multiple dependent surcharge.

Also attached on a separate page is and Abstract of the Disclosure.

Respectfully submitted,



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MARKED-UP VERSION OF THE CHANGES TO THE CLAIMS

3. (amended) Process according to [claim 1 or 2] claim 1, characterized in that also the temperature of the main processing step is kept below the plasticizing temperature of the PET-material.

4. (amended) Process according to [any of claims 1 to 3] claim 1, characterized in that for PET-pieces and/or milled PET-bottles the pre-processing step, that preferably is performed under environmental pressure, is performed at a temperature range of 140 to 190°C, preferably 150 to 160°C, and at simultaneous mechanic treatment or, respectively, applying power that causes heating, by means of at least one mixing and/or comminuting element, wherein the average dwell-time of the PET-material or, respectively, the duration of pre-processing, amounts to 35 to 65 min, preferably 40 to 60 min.

5. (amended) Process according to [any of claims 1 to 3] claim 1, characterized in that for PET -foils and/or PET-fibers and/or PET-flakes, the pre-processing step, that preferably is performed under environmental pressure, is performed at a temperature range of 170 to 200°C, preferably 180 to 200°C, and at simultaneous mechanic treatment or, respectively, power applying that causes heating, by at least one mixing and/or comminuting element, wherein the average dwell-time of the PET-material or, respectively, the duration of pre-processing, amounts to 10 to 30 min, preferably 10 to 15 min.

6. (amended) Process according to [any of claims 1 to 5] claim 1, characterized in that the PET-material is subjected to the pre-processing step in a continuous flow.

7. (amended) Process according to [any of claims 1 to 6] claim 1, characterized in that the pre-processed PET-material is subjected to an intermediate storage between the pre-processing step and the main-processing step, the duration of this storage corresponds to 80 to 120 % of the duration of pre-processing step, and that the pre-processed PET-material is kept during the intermediate storage and/or during conveying to main-

processing at a temperature that is as constant as possible, in particular 130 to 190°C, preferably 150 to 170°C.

8. (amended) Process according to [any of claims 1 to 7] claim 1, characterized in that during the main-processing step that is performed under vacuum, in particular under a pressure of less than 20 mbar, preferably less than 10 mbar, the pre-processed PET-pieces and/or the milled bottle material is mechanically treated at a temperature of 170 to 210°C, preferably 180 to 200°C, or is subjected to a power introduction that causes heating by at least one, preferably rotating, mixing and/or comminuting element, wherein the average dwell-time of the PET-material or the duration of the main-processing step, respectively, amounts to 40 to 100 min, preferably 50 to 90 min.

10. (amended) Process according to [any of claims 1 to 7] claim 1, characterized in that at the main-processing step that is performed under vacuum, the pre-processed PET-foils and/or PET-fibers are processed at a temperature of 160 to 210°C, preferably 170 to 205°C, or, respectively, are subjected to a mechanic power introduction that causes heating by at least one mixing and/or comminuting element, wherein the average dwell-time of the PET-material or the duration of the main-processing step, respectively, amounts to 5 to 25 min, in particular to 10 to 15 min.

12. (amended) Process according to [any of claims 5 to 11] claim 5, characterized in that at least one rotating mixing and/or comminuting element is used.

13. (amended) Process according to [any of claims 1 to 12] claim 1, characterized in that the PET-material is comminuted before pre-processing to sizes of 15 to 25 mm.

14. (amended) Process according to [any of claims 1 to 13] claim 1, characterized in that the PET-material to be processed is pre-comminuted and/or washed and/or pre-dried before the pre-processing step.

15. (amended) Process according to [any of claims 1 to 14] claim 1, characterized in that the PET-material is supplied from a main-processing apparatus (4) to the

extruder (8) under vacuum conditions or, respectively, that the vacuum existing within the main-processing apparatus (4) acts into the inlet section of the extruder (8).

16. (amended) Apparatus for recycling of PET-material, in which the PET-material to be processed is dried, crystallized and plasticized or, respectively, molten, and the melt, if desired after filtering, is processed to PET-granulate, for performing the process according to [any of claims 1 to 9] claim 1, characterized by two processing steps, in the first of which there is provided for pre-processing of the supplied PET-material a pre-processing device (3) having mechanical processing elements (5) for drying and simultaneously crystallizing the PET-material at elevated temperature and that this first step is followed by a second processing step comprising an evacuable main-processing device (4) having mechanical processing elements (5') for further drying, crystallizing and temperature increase of the PET-material supplied by the pre-processing device (3).

18. (amended) Apparatus according to [claim 16 or 17] claim 16, characterized in that as well within the pre-processing device (3) as within the main-processing device (4) there is provided at least one rotating mixing and/or comminuting element (5, 5') which mechanically treats and heats the PET-material.

21. (amended) Apparatus according to [any of claims 16 to 20] claim 16, characterized in that an intermediate storage means (6) is inserted between the pre-processing device (3) and the main-processing device (4), the volume of this storage means (6) corresponds to 100 to 200 % of the volume of the pre-processing device (3).

22. (amended) Apparatus according to [any of claims 6 to 21] claim 6, characterized in that between the pre-processing device (3) and the intermediate storage means (6) and between the intermediate storage means (6) and the main-processing device (4) a thermally isolated and/or heated conveyor unit (7) each is provided, preferably a conveyor screw or an extruder.

23. (amended) Apparatus according to [any of claims 16 to 22] claim 16, characterized in that the volume of the main-processing device (4) amounts to 80 to 200% of the volume of the pre-processing device (3), in particular to 100 to 180 %.

24. (amended) Apparatus according to [any of claims 16 to 23] claim 16, characterized in that an extruder (8) is connected to the main-processing device (4), in which extruder the PET-material taken from the main-processing device (4) is heated to a temperature of 260 to 275°C and is plasticized or molten, respectively.

26. (amended) Apparatus according to [claim 24 or 25] claim 24, characterized in that the extruder (8) comprises at least one de-gassing zone (9) to which a vacuum pump (10) is connected by which within the de-gassing zone (9) a pressure of less than 40 mbar, in particular less than 10 mbar, can be adjusted.

27. (amended) Apparatus according to [any of claims 16 to 25] claim 16, characterized in that a filtration device (11) for PET-melt is connected to the extruder (8) and that, if desired, a device (12) for producing finished products or semi-finished products, for example PET-granulate, is connected to this filtration device (11).

29. (amended) Apparatus according to [any of claims 16 to 28] claim 16, characterized in that the pressure in the main-processing device (4) is adjustable to less than 150 mbar, preferably less than 20 mbar.

30. (amended) Apparatus according to [any of claims 16 to 29] claim 16, characterized in that an additional heating for the pre-processing device (3) and/or for the main processing device (4) is provided.

## METHOD AND DEVICE FOR RECYCLING PET MATERIALS

### ABSTRACT OF THE DISCLOSURE

According to the inventive method for recycling PET materials and/or items consisting of PET, the PET material to be treated is heated in a pretreatment process, dried and at the same time crystallized at a high temperature. This pretreatment is followed by a main treatment in a vacuum. Said main treatment consists of re-drying a material that has been treated and re-crystallizing said material at a higher temperature than that used for the pretreatment. The material is preferably not softened or melted during the main treatment - the softening or melting does not take place until after the main treatment step. A device for carrying out this method has a pretreatment unit (3) in which the material to be treated is dried at a high temperature, crystallized at the same time and, optionally, also reduced. A main treatment device (4) in which the PET material supplied is dried, crystallized and heated to a higher temperature than that used in the pretreatment unit is connected to said pretreatment unit (3).

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Process and Apparatus for Recycling of PET-Material

The invention relates to a process and an apparatus for recycling of PET-material according to the introductory part of claim 1 or according to the introductory part of claim 16, respectively.

Under PET-material (material of polyethylene terephthalate) all PET-materials and/or PET-objects are to be understood, also those of BOPET (bi-oriented PET), in particular pieces, milled bottle material, foils, fibers, flakes and the like.

When recycling articles of polyethylene terephthalate or of polyethylene terephthalate-materials it is of importance that the PET-material to be recycled is as dry as possible in order to avoid a hydrolytic degradation of the molecule chains by the influence of hydrogen during plastifying or during the melting step. However, an efficient drying is possible only at elevated temperature at which the amorphous PET-particles or PET-parts adhere to each other. By these reasons, a crystallization of the PET-material should be obtained before drying. Such a crystallization can be obtained by uniformly moving or mechanically treating the particles at a temperature lower than the drying temperature, in any case at a temperature that is lower than the plastifying temperature.

However, since the PET-materials to be recycled or the articles consisting of PET, in particular PET-bottles, are mostly soiled and are washed and possibly previously comminuted, at which procedure a simultaneous soiling frequently cannot be avoided, in the most cases the material is discretely comminuted or milled, washed and dried. Such a pre-drying should be at least so efficient, that the moisture content does not exceed a value of 1.5 weight-% of the PET-material to be treated or to be recycled.

In particular, it is an object of the invention to provide for a process and an apparatus of the initially described kind by which PET-material is subjected to a quick recycling that is as much power saving as possible, wherein the PET-granulate produced from the melt obtained, or PET-particles made therefrom, have high viscosity-values, in particular a viscosity that can be compared with the viscosity values of the PET-material to be recycled. Further, the obtained melt or, respectively, the PET-granulate produced from the melt should meet the rules concerning food stuff techniques, that means that harmful substances or contaminations contained in the PET-material that is supplied to the recycling process, are eliminated as far as possible by a suitable treatment.

This object is achieved within a process of the initially named kind by the features stated in the characterizing part of claim 1. An inventive apparatus of the initially described kind is characterized by the features stated in the characterizing part of claim 16.

Therefore, a two-step treatment of the delivered our supplied PET-material is made, wherein, when pre-treating in a pre-treatment apparatus, no plastification of the PET-material is made, however a crystallization and a certain pre-densification at a simultaneous drying takes place. The pre-densification is obtained by a suitable

temperature by mechanical treatment of the PET-material or by power introduction into it. In particular, increasing or controlling of the temperature is made by the mechanical treatment of the PET-material or, respectively, by conversion of the rotational energy of at least one revolving mixing and/or comminuting element into thermic energy by reasons of the friction losses occurring.

During the main treatment in a main treatment apparatus, the PET-material is further dried and crystallized at an elevated temperature and is kept under a high vacuum for a certain mean dwell time. Again there is made a mechanical treatment or material condensation and introduction of power by at least one revolving mixing and/or comminuting element that by its rotation introduces the corresponding thermic energy into the PET-material and further heats it.

The main treatment that is effected under vacuum, reduces the remaining humidity to a pre-determined defined mean value and has also the effect that volatile harmful substances are separated from the PET-material.

The temperature at the main treatment is kept below the melting temperature of the PET-material; in particular about 40 to 60°C below the melting temperature. However it is desired to keep this temperature as high as possible.

Only after the main treatment, the PET-material conveyed off is plasticized by an extruder that preferably is directly connected to the main treatment apparatus. By the direct, vacuum-tight connection, the vacuum within the main treatment apparatus can act into the inlet section of the extruder. This extruder comprises a plasticising zone followed by a compression and damming zone. This damming zone is followed by a degassing or evacuating zone in which volatile substances are sucked off from the melt by a vacuum, in particular by a high vacuum. Within this, a one-step or multi-step degassing can be provided. It is also possible to provide a plurality of compression zones and decompression zones having different values of the vacuum one behind the other. Thereby also persistent contaminations or those which are difficult to vaporize can be vaporized off.

By a suitable selection of the temperatures and of the dwell times within the pre-treatment apparatus and within the main treatment apparatus, the viscosity value of the melt obtained from the extruder and of the PET-granulate produced from the melt can be adjusted. By suitably long dwell times and suitably high temperatures within the vacuum, a positive influence onto the viscosity is effected or, respectively, a re-polymerization takes place.

Advantageous embodiments of the invention can be seen from the following description, the claims and the drawing. In the drawing, two exemplary embodiments of the invention are nearer shown.

Fig. 1 shows an embodiment of the invention in which the PET-material is directly supplied from the pre-treatment apparatus to the main treatment apparatus. Fig. 2 shows

an embodiment of the invention in which the PET-material is supplied from the pre-treatment apparatus to the main treatment apparatus via an intermediate storage means.

PET to be recycled, in particular PET-material and/or objects of PET, can be comminuted within a comminuting unit 1 and can be supplied via a washing unit 2 to a unit 14 for pre-drying. Used PET-bottles and PET-containers to be recycled are in an advantageous manner pre-sorted and are pre-milled to an average size of about 15 to 25 mm. The residual humidity of this milled, washed and dried PET-material should be as less as possible by reasons of process technology and should amount to 1.5 % by weight maximally.

For the pre-treatment, the PET-material is supplied to a pre-processing apparatus 3 for pre-drying, in which it can be also comminuted, if desired. Within the pre-processing apparatus 3 a heating and a crystallization of the material takes place simultaneously with drying. For this, within the pre-treatment apparatus 3 a rotating mixing and/or comminuting element 5 is provided that rotates with a circumferential speed of 9 to 15 m/s. Thereby it is ensured, that the mechanic motor power is converted into heat by friction between the mixing tools and the PET-pieces or the PET-material. The throughput of the PET-material is so controlled that its average dwell-time amounts to about 35 to 65 min, preferably 40 to 60 min. Within this, the temperature of the PET-material is adjusted to about 140 to 190°C, preferably 150 to 160°C. At this temperature, the surface water evaporates immediately and due to the long dwell-time also a substantial portion of the absorbed humidity or other absorbed contamination emigrates. It is not absolutely necessary, however of advantage, if processing of the PET-material within the pre-processing apparatus 3 is made under vacuum. Thereby, the dwell-time of the PET-material within the pre-processing apparatus 3 can be decreased, or, respectively, the volume of this apparatus can be correspondingly reduced. Such processing in particular is then justified if the material to be processed should be highly protected against oxidation, or, respectively, if comminuting within the pre-processing unit 3 is not necessary.

From the pre-treatment apparatus 3, to which the PET-material is supplied, preferably continuously, in particular by a supplying unit 18, for example a conveyor belt, the PET-material is conveyed off by a conveyor unit 7, in particular a conveyor screw. It can be conveyed directly (Fig. 1) or via an intermediate storage means 6 (Fig. 2) and via a further conveyor unit, for example a conveyor screw 17, to a main processing apparatus 4.

Preferably, the main processing apparatus 4 is supplied with heated PET-material.

The conveyor unit 7 is filled by the pre-processing apparatus 3 and is kept at a temperature of 140 to 170°C, in particular 150 to 160°C.

Within the main processing apparatus 4, the particles of PET-material, which partially loosely adhere to each other, are mainly broken to pieces by a rotating mixing and/or comminuting element 5', and the temperature of the synthetic plastic material is



increased to 170 to 210°C, in particular 180 to 210°C. The circumferential speed of the mixing and/or comminuting element 5' corresponds substantially to the circumferential speed of the mixing and/or comminuting element 5 within the pre-processing apparatus 3 and also amounts to about 9 to 15 m/s.

The volume of the receptacle of the main processing device 4 and the throughput of the material are so chosen that an average dwell-time for the PET-material of 40 to 90 min, in particular 50 to 90 min is obtained. The pressure within the main processing apparatus 4 is adjusted to a value of less than 20 mbar, preferably, for obtaining best results, to less than 10 mbar.

Filling of the main processing apparatus 4 can be made directly by means of the screw 7 or by means of a sluice device 15, that operates with two gas-tight or vacuum-tight slide gates 15' and thus introduces the PET-material in batch quantities. A vacuum pump 16 is connected to the main processing apparatus 4.

An extruder 8 is connected to the main processing apparatus 4 and further processes the PET-material delivered from the main processing device 4. Within the extruder 8, the PET-material is plasticized or molten. The extruder 8 may comprise at least one degassing-zone 9, whereby a vacuum pump 10 is connected to the degassing opening in the extruder housing in order to adjust a pressure of less than 10 mbar, in particular less than 5 mbar. By providing at least one degassing zone and, if desired, applying vacuum, the separation of humidity and/or other separation products can be influenced. Preferably, the extruder 8 comprises a double degassing zone.

It has been shown that if the above mentioned processing parameters are observed, a viscosity value of the molten PET-material or of the PET-granulate could be obtained that was about 5 % above the viscosity values of the supplied PET-material. This viscosity increase could be obtained in particular by the two-step-processing as well as by the corresponding adjustment of temperature, dwell-times, vacuum pressures and number of vacuum-zones or degassing zones. It has further been shown that beside of the humidity also other separation products could be separated within the extruder by suitably adjusting temperature, pressure, dwell-times and shearing.

Within a preferred embodiment of the invention, the extruder 8 is connected gas-tightly to the main processing apparatus 4 so that the vacuum of the main processing apparatus 4 acts into the extruder inlet.

A screening or filtration device 11 may be connected to the extruder 8 and the melt passing through it is supplied to a device 12 for the production of PET-granulate. Between the extruder 8 and the filtration device 11 a device 13 for measuring the viscosity of the obtained melt can be disposed.

It is of advantage, if the PET-material is conveyed from the pre-processing apparatus 3 to the main processing apparatus 4 under exclusion of air in order to exclude that the pre-dried PET-material is moistened again.

In order to avoid that the vacuum applied to the extruder 8, in particular within the degassing-zones, acts back to the main processing apparatus 4, provisions are to be made that the compression within the extruder 8, or the tightening action of the material conveyed by the extruder are so great that any reaction of the vacuum to the main processing device 4 is avoided. The same holds for a reaction of the vacuum of the main processing apparatus 4 to the pre-processing apparatus 3. In this case, however, a reaction can be excluded by providing the sluice with suitable sluice sliding gates 15'. If the pre-processing apparatus 4 is directly connected to the main processing apparatus 4, the conveying screw must be vacuum-tight.

When supplying to the main processing apparatus 4, the supplied PET-material is within the sluice that is pre-disposed with respect to the main processing apparatus 4, already subjected to the vacuum so that no substantial pressure decrease can take place within the main processing apparatus 4. This is of advantage because the amount of the vacuum has a direct influence on the separation of the harmful substances and on the viscosity.

When an intermediate storage means 6 (Fig. 2) is used, an irregular supply of the pre-processing apparatus 3 can be tolerated.

Mostly it is sufficient to obtain the temperature increase of the supplied PET-material within the pre-processing device 3 and within the main processing device 4 by the introduction of power by means of the rotating mixing and/or comminuting elements 5, 5'. In addition, the pre-processing device 3 and/or the main processing device 4 may also be heated.

In the course of the pre-treatment and of the main-treatment, the PET-material can also be comminuted, the mixing and/or comminuting elements have then to be correspondingly constructed.

The drive means for the mixing and/or comminuting elements 5, 5' or, respectively, for the conveyor means 7, 17 or, respectively, for the extruder 8 are not shown or have been designated by M, respectively.

## Claims:

1. Process for recycling of PET-material, in which the PET-material to be processed is heated by movement and thereby is dried, crystallized and plasticized or, respectively, molten, and subsequently, if desired after filtering, is processed to PET-granulate, characterized in that the supplied PET-material is processed in two steps, wherein in the first step the PET-material is subjected to a pre-processing by subjecting it to mechanical power and thereby heating it and drying it at an elevated temperature, and simultaneously crystallizing it, and that then within the second step that precedes plasticizing or, respectively, melting, the PET-material is subjected to a main processing in which the PET-material under vacuum conditions is again dried and further crystallized by subjecting it to mechanical power, wherein this main processing is performed at a temperature that is increased when compared with the pre-processing.
2. Process according to claim 1, characterized in that the material to be processed is pre-comminuted and/or washed and/or pre-dried before the pre-processing step.
3. Process according to claim 1 or 2, characterized in that also the temperature of the main processing step is kept below the plasticizing temperature of the PET-material.
4. Process according to any of claims 1 to 3, characterized in that for PET-pieces and/or milled PET-bottles the pre-processing step, that preferably is performed under environmental pressure, is performed at a temperature range of 140 to 190°C, preferably 150 to 160°C, and at simultaneous mechanic treatment or, respectively, applying power that causes heating, by means of at least one mixing and/or comminuting element, wherein the average dwell-time of the PET-material or, respectively, the duration of pre-processing, amounts to 35 to 65 min, preferably 40 to 60 min.
5. Process according to any of claims 1 to 3, characterized in that for PET-foils and/or PET-fibers and/or PET-flakes, the pre-processing step, that preferably is performed under environmental pressure, is performed at a temperature range of 170 to 200°C, preferably 180 to 200°C, and at simultaneous mechanic treatment or, respectively, power applying that causes heating, by at least one mixing and/or comminuting element, wherein the average dwell-time of the PET-material or, respectively, the duration of pre-processing, amounts to 10 to 30 min, preferably 10 to 15 min.

6. Process according to any of claims 1 to 5, characterized in that the PET-material is subjected to the pre-processing step in a continuous flow.
7. Process according to any of claims 1 to 6, characterized in that the pre-processed PET-material is subjected to an intermediate storage between the pre-processing step and the main-processing step, the duration of this storage corresponds to 80 to 120 % of the duration of pre-processing step, and that the pre-processed PET-material is kept during the intermediate storage and/or during conveying to main-processing at a temperature that is as constant as possible, in particular 130 to 190°C, preferably 150 to 170°C.
8. Process according to any of claims 1 to 7, characterized in that during the main-processing step that is performed under vacuum, in particular under a pressure of less than 20 mbar, preferably less than 10 mbar, the pre-processed PET-pieces and/or the milled bottle material is mechanically treated at a temperature of 170 to 210°C, preferably 180 to 200°C, or is subjected to a power introduction that causes heating by at least one, preferably rotating, mixing and/or comminuting element, wherein the average dwell-time of the PET-material or the duration of the main-processing step, respectively, amounts to 40 to 100 min, preferably 50 to 90 min.
9. Process according to claim 8, characterized in that the main processing is performed at a pressure of less than 20 mbar, preferably less than 10 mbar.
10. Process according to any of claims 1 to 7, characterized in that at the main-processing step that is performed under vacuum, the pre-processed PET-foils and/or PET-fibers are processed at a temperature of 160 to 210°C, preferably 170 to 205°C, or, respectively, are subjected to a mechanic power introduction that causes heating by at least one mixing and/or comminuting element, wherein the average dwell-time of the PET-material or the duration of the main-processing step, respectively, amounts to 5 to 25 min, in particular to 10 to 15 min.
11. Process according to claim 10, characterized in that the main processing step is performed at a pressure less than 150 mbar, preferably less than 50 mbar.
12. Process according to any of claims 5 to 11, characterized in that at least one rotating mixing and/or comminuting element is used.
13. Process according to any of claims 1 to 12, characterized in that the PET-material is comminuted before pre-processing to sizes of 15 to 25 mm.

14. Process according to any of claims 1 to 13, characterized in that the PET-material to be processed is pre-comminuted and/or washed and/or pre-dried before the pre-processing step.
15. Process according to any of claims 1 to 14, characterized in that the PET-material is supplied from a main-processing apparatus (4) to the extruder (8) under vacuum conditions or, respectively, that the vacuum existing within the main-processing apparatus (4) acts into the inlet section of the extruder (8).
16. Apparatus for recycling of PET-material, in which the PET-material to be processed is dried, crystallized and plasticized or, respectively, molten, and the melt, if desired after filtering, is processed to PET-granulate, for performing the process according to any of claims 1 to 9, characterized by two processing steps, in the first of which there is provided for pre-processing of the supplied PET-material a pre-processing device (3) having mechanical processing elements (5) for drying and simultaneously crystallizing the PET-material at elevated temperature and that this first step is followed by a second processing step comprising an evacuable main-processing device (4) having mechanical processing elements (5') for further drying, crystallizing and temperature increase of the PET-material supplied by the pre-processing device (3).
17. Apparatus according to claim 16, characterized in that the pre-processing device (3) also comminutes the PET-material.
18. Apparatus according to claim 16 or 17, characterized in that as well within the pre-processing device (3) as within the main-processing device (4) there is provided at least one rotating mixing and/or comminuting element (5, 5') which mechanically treats and heats the PET-material.
19. Apparatus according to claim 18, characterized in that for comminuting in particular of PET-pieces and/or milled bottle material at least one mixing and comminuting element (5, 5') in the pre-processing device (3) rotates with a circumferential speed of 9 to 15 m/s and in the main processing device (4) with a circumferential speed of also 9 to 15 m/s.
20. Apparatus according to claim 18, characterized in that for comminuting in particular of PET-foils and/or PET-fibers and/or PET-flakes at least one mixing and comminuting element (5, 5') is provided as well within the pre-processing device (3) as within the

main processing device (4), which element, respectively, rotates with a circumferential speed of 15 to 35 m/s, preferably 20 to 30 m/s.

21. Apparatus according to any of claims 16 to 20, characterized in that an intermediate storage means (6) is inserted between the pre-processing device (3) and the main-processing device (4), the volume of this storage means (6) corresponds to 100 to 200 % of the volume of the pre-processing device (3).
22. Apparatus according to any of claims 6 to 21, characterized in that between the pre-processing device (3) and the intermediate storage means (6) and between the intermediate storage means (6) and the main-processing device (4) a thermally isolated and/or heated conveyor unit (7) each is provided, preferably a conveyor screw or an extruder.
23. Apparatus according to any of claims 16 to 22, characterized in that the volume of the main-processing device (4) amounts to 80 to 200 % of the volume of the pre-processing device (3), in particular to 100 to 180 %.
24. Apparatus according to any of claims 16 to 23, characterized in that an extruder (8) is connected to the main-processing device (4), in which extruder the PET-material taken from the main-processing device (4) is heated to a temperature of 260 to 275°C and is plasticized or molten, respectively.
25. Apparatus according to claim 24, characterized in that the extruder (8) is gas-tightly or, respectively, vacuum-tightly connected to the main-processing device (4) and that the pressure within the inlet section of the extruder (8) is connected to the pressure within the interior of the main-processing device (4), or, respectively, that the pressure within the main-processing apparatus (4) corresponds to the pressure within the inlet section of the extruder (8).
26. Apparatus according to claim 24 or 25, characterized in that the extruder (8) comprises at least one de-gassing zone (9) to which a vacuum pump (10) is connected by which within the de-gassing zone (9) a pressure of less than 40 mbar, in particular less than 10 mbar, can be adjusted.
27. Apparatus according to any of claims 16 to 25, characterized in that a filtration device (11) for PET-melt is connected to the extruder (8) and that, if desired, a device (12) for producing finished products or semi-finished products, for example PET-granulate, is connected to this filtration device (11).

28. Apparatus according to claim 27, characterized in that between the extruder (8) and the filtration device (11) a measuring device (13) for measuring the viscosity of the melt is disposed.
29. Apparatus according to any of claims 16 to 28, characterized in that the pressure in the main-processing device (4) is adjustable to less than 150 mbar, preferably less than 20 mbar.
30. Apparatus according to any of claims 16 to 29, characterized in that an additional heating for the pre-processing device (3) and/or for the main processing device (4) is provided.

Abstract:

Within a process for recycling of PET-material and/or objects of PET, the PET-material to be processed is heated and dried in the course a pre-treatment step and simultaneously is crystallized at elevated temperature. This pre-treatment step is followed by a main-treatment step under vacuum. In this main-treatment step, the processed material is again dried and crystallized at a temperature that is higher than the temperature of the pre-treatment step. Preferably, also in the main-treatment step no plasticizing of the material takes place, the plasticizing or, respectively, melting of the material takes place only after the main-processing step.

An apparatus for performing this process comprises a main-processing device (3) in which the processed material is dried and simultaneously crystallized at elevated temperature, and, if desired, is also comminuted. A main-processing device (4) is connected to this pre-processing device (3), in which main-processing device the supplied PET-material is dried, crystallized and heated to a temperature that is higher as the temperature within the pre-treatment device.

(Fig. 1)



FIG. 1

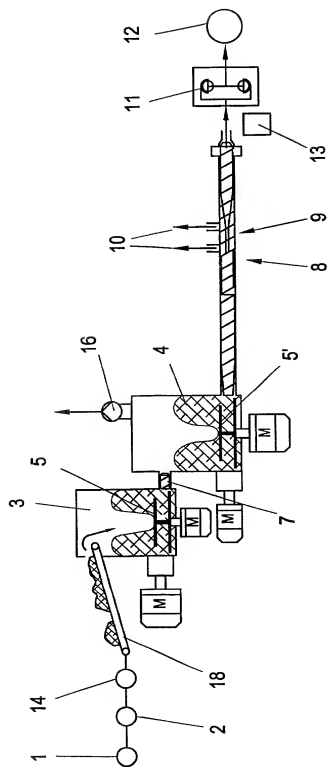
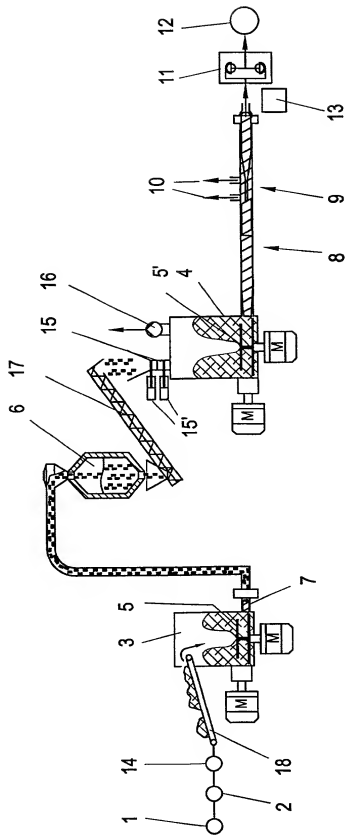


FIG. 2



**DECLARATION FOR UTILITY OR  
DESIGN  
PATENT APPLICATION  
(37 CFR 1.63)**

Attorney Docket Number

089478-000000US

First Named Inventor

Helmut Bacher, et al.

COMPLETE IF KNOWN

Application Number

Filing Date

An Unit

Examiner Name

☐ Declaration  
Submitted after Initial  
Filing (surcharge  
(37 CFR 1.16(e))  
required)

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Filing (surcharge  
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As a below named inventor, I hereby declare that:

My residence, mailing address, and citizenship are as stated below next to my name

I believe I am the original and first inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

**METHOD AND APPARATUS FOR RECYCLING PET-MATERIALS**

(Title of the invention)

The specification of which

☒ is attached hereto

OR

☐ was made (MM/DD/YYYY)

as United States Application Number or PCT International

Application Number and was amended on (MM/DD/YYYY) (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above

I acknowledge a duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for example, but not limited to, information relating to the continuation-in-part application

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, invention, design, plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country, other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, invention, design, plant breeder's rights certificate(s), or of any PCT international application, or filing date before that of the above identified foreign priority application(s)

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certificate Copy Attached	
				YES	NO
1620/99	Austria	09 22 1999	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PCT/AT 00/00255	International	09 22 2000	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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☐ Additional foreign application numbers are listed on a supplemental priority data sheet (PTO/SB02B) attached hereto

(Page 1 of 2)

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# DECLARATION — Utility or Design Patent Application

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☐ A petition has been filed for this unsigned inventor

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☐ Additional inventors are being named on the supplemental Add'l Inventor(s) sheet(s) PTO/SB/02A attached hereto

PTO/SPP (1-10)

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## DECLARATION

ADDITIONAL INVENTOR(S)  
Supplemental Sheet  
Page 3 of 3

Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor	
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Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor	
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Inventor's Signature		Date	
Residence City	State	Country	Citizenship
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Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor	
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Applicant :  
Serial No. :  
Filed :  
Title :

VERIFIED STATEMENT CLAIMING SMALL ENTITY STATUS  
37 CFR 1.9(f) and 1.27(b)  
INDEPENDENT INVENTOR

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under section 41(a) and (b) of Title 35, U.S.C., to the Patent and Trademark Office with regard to the invention entitled \_\_\_\_\_

METHOD AND APPARATUS FOR RECYCLING PET-MATERIALS

described in the specification filed herewith

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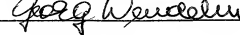
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Helmut BACHER

Helmut SCHULZ

Georg WENDELIN

By

Dated: February 15, 2002